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Short communication

Palm Oil Based-Diet Enhances Growth Performance of Asian Seabass (*Lates calcarifer*, Centropomidae) Juveniles

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Abstract

The replacement of dietary marine fish oil with vegetable oils was examined in Asian seabass juveniles (*Lates calcarifer,* Centropomidae), over the course of a 7-week feeding trial. Four fish meal-based diets were formulated to contain iso-ingredients but with different sources of lipid including refined, bleached and deodorized palm olein (RBDPO), soybean oil (SBO) and canola oil (CNO), and their performance was compared with the control diet (FO) which contained cod liver oil as the added lipid source. The experimental diets were fed until satiation twice a day to triplicate groups of 12 fish in cylindrical cages that were placed in a 20 tonne polyethylene seawater tank. Fish fed diet RBDPO had significantly higher ($P<0.05$) weight gain than other fish groups at the end of feeding trial. The feed conversion ratio of diet RBDPO (1.52) was not significantly different from the control diet (1.53), and this value was better than the other experimental diets (1.98 in SBO and 1.75 in CNO). High survival rates of seabass juveniles were observed in the present study (95.5 to 100%) and were not affected by the dietary treatments. In view of the availability and competitive price of palm oil in the global market, it can be concluded that palm oil can be an excellent source of lipid in the commercial feed of Asian seabass.

Introduction

There has been a continuous demand for Asian seabass in Asia Pacific region due to its good taste and competitive price in the markets. Like many other aquaculture species, one of the major hurdles in any fish farm is increased production cost which come from feed cost (>50%) and variable cost. Conventional feed ingredients such as fish meal and fish oil are still widely used in the formulation of most marine carnivorous species including Asian seabass. Both of these commodities are very expensive especially in countries like Malaysia where fish meal and fish oil have to be imported. Finding suitable alternatives to the conventional feed ingredients will help reduce the dependency on fish-based feeds and cost of feeding. Refined, bleached, deodorized palm olein (RBDPO) is one the palm oil products and abundantly available in Asian market. It is produced by refining the crude palm oil to remove impurities and produce the desired colour in RBDPO (Young, 1987). Palm oil products have been successfully used to partially replace fish oil in the diets of catfishes (Ng et al. 2000; Ng et al. 2004), salmonids

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(Fonseca-Madrigal et al. 2005), tilapias (Ng et al. 2001) and mouse grouper (*Cromileptes altivelis*, Serranidae) (Shapawi et al. 2008). Unfortunately, there is limited information on the potential of palm oil in replacing fish oil in the diets of Asian seabass. Other vegetable oils such as soybean oil, canola oil or linseed oil have been tested in the diets of seabass (*Lates calcarifer*) without any adverse effects on the growth performance of the fish (Raso and Anderson, 2003). Apart from this, little work has been done on the potential of vegetable oils in Asian seabass. In a recent review on fish oil replacement in finfish by Turchini et al. (2009), it was concluded that in marine carnivorous species, the effect of fish oil replacement is still not fully understood and has not been fully quantified. In view of the promising results from the previous studies on fish oil replacement with vegetable oils, a 7-week feeding trial was conducted to evaluate the potential of palm oil and other vegetable oils to support growth of Asian seabass.

Materials and Methods

The initial weight and total length of juveniles Asian seabass used were 5.10 ± 0.3 g and 7.50 ± 0.2 cm, respectively. The experimental fish were obtained from a local private farm in Sabah, Malaysia and were stocked at 15 tails per cage (47.8 cm in diameter and 61.7 cm in height) and these cages were placed in a 20 tonne tank with flow-through water system. Four fish meal-based experimental diets with different types of dietary lipid sources were formulated to meet the dietary protein and lipid requirements of juvenile Asian seabass (42.0% protein and 10% lipid- Catacutan and Coloso (1995); Boonyaratpalin (1997)). Added dietary lipid (6.8%) was in the form of either fish oil (FO), refined, bleached, deodorized palm olein (RBDPO), canola oil (CNO) or soybean oil (SBO), and another 3.2% was from residual oil from fish meal. Formulated diet containing FO was used as a control treatment (Table 1). The triplicate groups of juvenile Asian seabass were fed twice daily (11.00 am and 4.00 pm) by hand until satiation. Growth, feed conversion ratio and survival rates were calculated at the end of the experiment following the formula below:

$$\text{Length Gain (\%)} = \frac{\text{Total Length (Final)} - \text{Total Length (Initial)} \times 100}{\text{Total Length (Initial)}}$$

$$\text{Weight Gain (\%)} = \frac{\text{Body Weight (Final)} - \text{Body Weight (Initial)} \times 100}{\text{Body Weight (Initial)}}$$

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Dry Weight Feed Given (g)}}{\text{Wet Weight Gain (g)}}$$

$$\text{Survival (\%)} = \frac{\text{Final Number Fish} \times 100}{\text{Initial Number Fish}}$$

Dried samples of experimental diets were subjected to dry matter, ash, crude protein, crude lipid, and crude fiber analyses following standard methods described by AOAC (1990). One-way ANOVA was used to compare the length gain, weight gain, FCR and survival rate. Homogeneity of variances was tested with Levene’s test and multiple comparisons among treatments were performed with a Tukey HSD post-hoc test. Significance level was set at P<0.05. Statistical package SPSS v.11.0 for Windows was used for all statistical analyses.

Table 1. Dietary ingredients and proximate composition of experimental diets (g·100 g^{-1} diet)

	Experiment Diets			
Ingredient /100 g	**FO**	**RBDPO**	**CNO**	**SBO**
Danish Fish Meal	60.9	60.9	60.9	60.9
Tapioca Starch	13.8	13.8	13.8	13.8
Carboxylmethylcelulose (CMC)	1.5	1.5	1.5	1.5
Dicalcium Phosphate	1	1	1	1
Vitamin Premix*	2	2	2	2
Mineral Premix**	1	1	1	1
α- cellulose	13	13	13	13
Cod liver oil	6.8	-	-	-
RBD (Palm Olein)	-	6.8	-	-
Canola Oil	-	-	6.8	-
Soybean Oil	-	-	-	6.8
Proximate Composition (% dry matter)				
Dry matter	9.2 ± 0.1	9.1 ± 0.1	9.2 ± 0.2	8.9 ± 0.1
Crude protein	49.3 ± 0.1	49.5 ± 0.2	49.3± 0.1	49.4 ± 0.3
Ether extract	10.5 ± 0.2	10.8 ± 0.2	10.3 ± 0.2	10.2 ± 0.1
Ash	12.7 ± 0.3	12.6 ± 0.4	12.9 ± 0.1	12.7 ± 0.1

*Contained (as g·kg^{-1}): ascorbic acid, 45; inositol, 5; choline chloride, 75; niacin, 4.5; riboflavin, 1; pyridoxine.HCL, 1; thiamin mononitrite, 0.92; calcium-d-panthothenate, 3: retinyl acetate, 0.6; cholecalciferol, 0.083; menadione sodium bisulphate, 1.67; DL-α-tocopheryl acetate (powder 500 IU·g^{-1}), 8; d-biotin, 0.02; folic acid, 0.09; vitamin B12, 0.00135; cellulose, 854.11.

** Reagent grade. Contained (as g·kg^{-1}): calcium phosphate.H_2O (MDCP), 397.65; calcium lactate, 327; ferrous sulphate.H_2O, 25; magnesium sulphate.$7H_2O$, 137; potassium chloride, 50; sodium chloride, 60; potassium iodide, 0.15; copper sulphate.$5H_2O$, 0.785; manganese oxide, 0.8; cobalt carbonate, 0.1; zinc oxide, 1.5; sodium selenite.$5H_2O$, 0.02.

Table 2. Growth performance, FCR and survival rate of Asian seabass.

	Experimental Diets			
	FO	**RBDPO**	**SBO**	**CNO**
Final weight (g)	10.98 ± 1.43^{ab}	12.90 ± 1.1^{a}	10.50 ± 0.71^{b}	9.01 ± 1.18^{b}
Weight gain (%)	115.47 ± 8.4^{b}	152.94 ± 7.6^{a}	102.56 ± 5.9^{bc}	81.01 ± 7.0^{c}
Length gain (%)	24.71 ± 3.8^{ab}	32.60 ± 3.9^{a}	23.05 ± 1.7^{b}	18.57 ± 3.1^{b}
FCR	1.53 ± 0.03^{a}	1.52 ± 0.11^{a}	1.98 ± 0.32^{a}	1.75 ± 0.16^{a}
Survival rate (%)	100 ± 0.00^{a}	100 ± 0.00^{a}	95.6 ± 7.7^{a}	100 ± 0.00^{a}

Results and Discussion

All experimental diets had similar levels of moisture, dry matter, crude protein, crude lipid and ash (Table 1). Asian seabass fed with RBDPO showed higher final weight and total length gain compared to fish fed FO, SBO and CNO at the end of feeding trial. However these values were not significantly different from those fed FO. Weight gain of fish fed RBDPO was significantly higher ($P<0.05$) (152.94 ± 7.6%) than other fish groups (81.01 ± 7.0 – 115.47 ± 8.4%). No significant differences ($P>0.05$) were detected in term of FCR values. The best FCR was obtained in RBDPO treatment with value of 1.52 ± 0.11. FCRs of other feeds were 1.53 ± 0.03 (FO), 1.75 ± 0.16 (CNO) and 1.98 ± 0.32 (SBO) as shown in Table 2. High survival rates of the juvenile Asian seabass were observed in the present study whereby 100% survivals were recorded in FO, RBDPO and CNO treatments. Survival rate of juvenile Asian seabass fed with SBO was 95.6 ± 7.7%.

In the present study, improved growth performance and efficient feed utilization of juvenile Asian seabass were observed when fed RBDPO diet. This finding is considered very important in view of the urgency to find suitable alternative lipid sources in aquafeed industry. In addition, palm oil products can be obtained in large quantity and consistent supply in the Asian market with cheaper price compared to fish oil and other vegetable oils such as SBO and CNO. Little information is currently available on the potential of palm oil as dietary lipid source in Asian seabass, making comparison difficult. However, the present finding is in agreement with a study on the evaluation of palm oil products in pelleted feed for a tropical bagrid catfish (*Mystus nemurus*, Bagridae) by Ng et al. (2000). In this study, catfish fed diets with RBDPO showed significantly higher growth rates compared with fish fed other diets based on FO, corn oil, SBO and crude palm oil. In African catfish, the final weight and weight gain of fingerlings fed FO diet was significantly lower than those fed palm oil-based diets (Ng et al. 2003). In our previous studies on fish oil replacement with vegetable oils in humpback grouper (Shapawi et al. 2008), growth performance of fish fed RBDPO was not significantly different from the control diet (FO) and other diets based on CPO, SBO and CNO. Other fish species such as tilapia (Al-Owafeir and Belal, 1996), salmonids (Oo et al. 2007) and climbing perch (Varghese and Oommen, 2000) have also shown promising results when fed diets with palm oil products as a dietary lipid source.

Asian seabass was reported to require n-3 highly unsaturated fatty acids (HUFA) of about 1.0 to 1.7% of the diet (Boonyaratpalin, 1997). In the present study, 68% of fish oil was replaced by the vegetable oils. The remaining oil (32%) was from the residual oil in fish meal. Even though the HUFA content of the experimental diets in the present study was not examined, the level of HUFA in RBDPO diet seems to be sufficient based on the good growth, survival and feed utilization of the fish. Palm oil is characterized by high level of saturated and monoenoic fatty acids of more than 42% of total fatty acids (Ng et al. 2000; Shapawi et al. 2008), in addition to high level of vitamin E (Nesaretnam and Muhammad, 1993). Fish are normally able to utilize lipid with high levels of saturated and monoenoic fatty acids as an energy source when the essential fatty acid requirements are fulfilled (Ng et al. 2000). According to Henderson (1996), there is a possibility of substrate preference in fish for saturated and monosaturated fatty acids over polyunsaturated fatty acids (PUFA), which may explain the good performance of RBDO diet in the present study. The presence of high vitamin E in palm oil might also contribute to the good performance in RBDPO diet since this can prevent oxidative stress in the fish (Baker and Davies, 1996). Except for the FCR values, the growth performances of fish fed SBO and CNO diets in the present study were comparable to the control diet. A study conducted by Raso and Anderson (2003) revealed that SBO and CNO can be used to support good growth and FCR in barramundi juveniles (*Lates calcarifer*). Therefore, partial replacement of fish oil with either SBO or CNO is possible in the diets of Asian seabass juveniles. However, in view of the availability, competitive price of palm oil in the market and good performance of RBDPO in the present study, RBDPO is preferred over SBO and CNO to replace fish oil in the commercial diets of Asian seabass. At least 65% of the dietary lipid source in the diet for Asian seabass can be based on RBDPO as long as good quality fish meal is used as a sole dietary protein source.

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